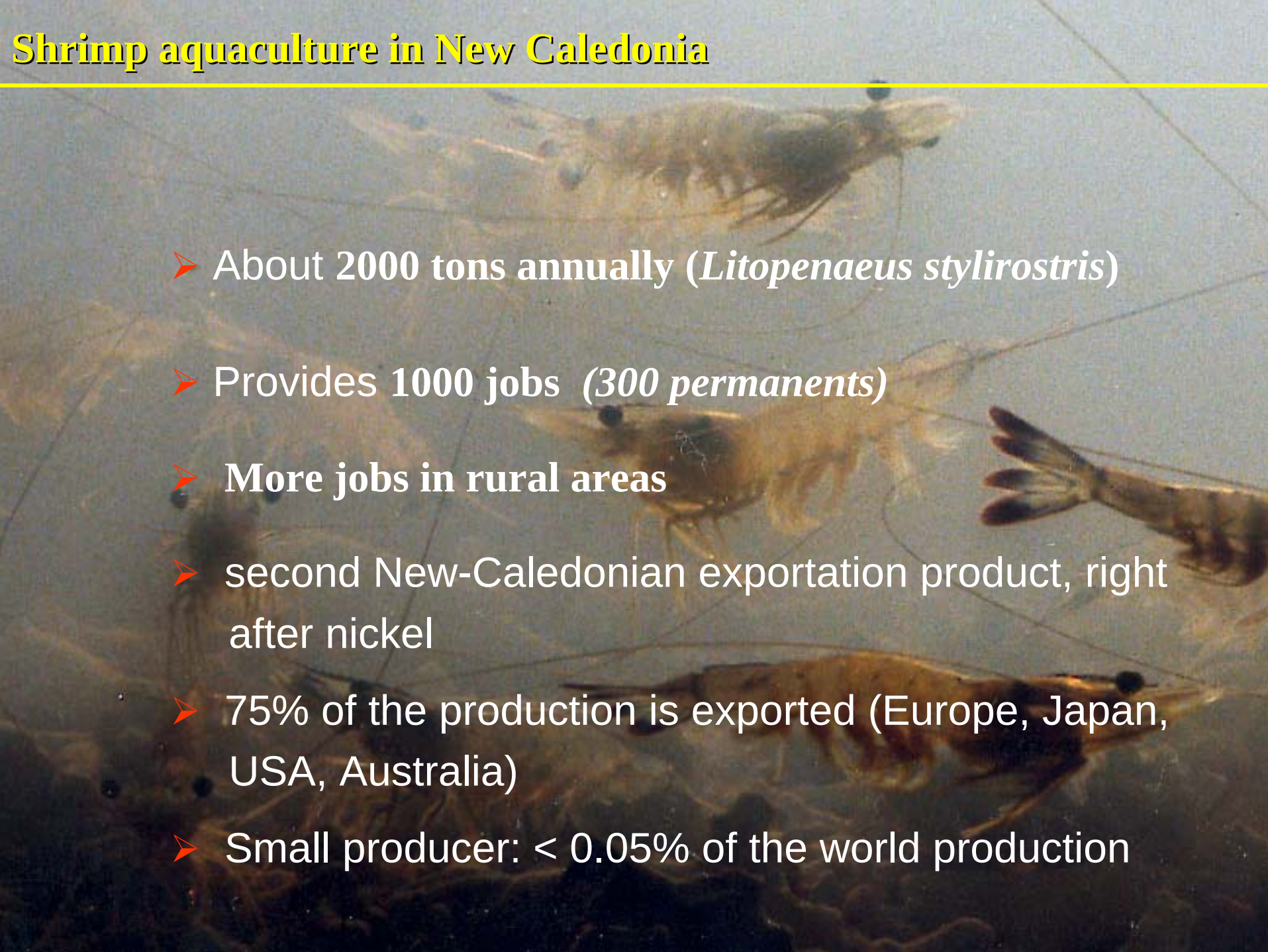
Lagoon water quality and shrimp farming: a state of knowledge

Dr Hugues Lemonnier

Ifremer

Shrimp aquaculture in New Caledonia



- About **2000 tons annually (*Litopenaeus stylirostris*)**
- Provides **1000 jobs** ***(300 permanents)***
- **More jobs in rural areas**
- second New-Caledonian exportation product, right after nickel
- 75% of the production is exported (Europe, Japan, USA, Australia)
- Small producer: < 0.05% of the world production

Shrimp aquaculture in New Caledonia

- High production costs (small producer, high labour price, high energy price, far from customers)
- Requires specific markets
- **Requires high quality products**
- With certification quality
- Consumer safety
- Environmental preservation

Shrimp aquaculture in New Caledonia

Shrimp aquaculture in New Caledonia

- **ponds range between 3 and 11 ha**
- Shrimp density: **15 to 35 /m²**
- **from 30 mg to 30 g**
- **Input: feed** (FCR = 2), **Fertilizer** (Urea, without Phosphates) **sea water** (5% to 30%) **and aeration**
- **Duration: about 200 days**

Water exchange is used:

- to flush nutrients and phytoplankton

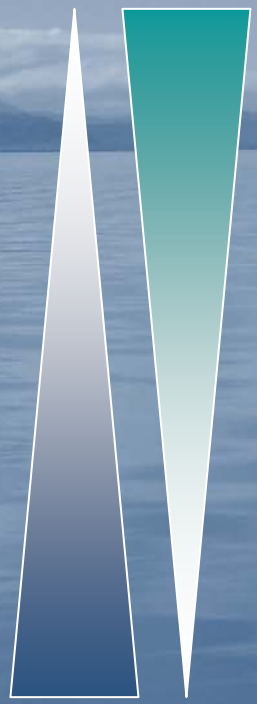
- to remove toxic metabolite wastes

- to dilute pond water to avoid high salinity

Effect of ecosystem characteristics on shrimp production

Ecosystem features

Organic matter accumulation capacity



Water renewal capacity

High confinement
(Low energy)

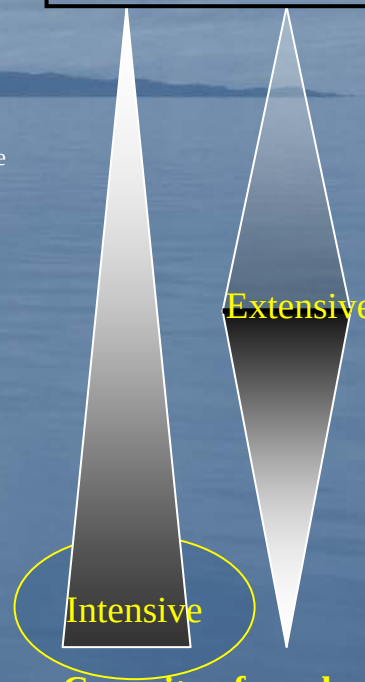
Dystrohypertrophic
-Trapping of organic matter
- Oxygen deficit
- Ssulfate reducing bacteria
-Denitrification
-Very high heterotrophic bacterial abundance
-Sinking of small particles

Eutrophic
-High autotrophic primary and secondary production
-High phytoplankton concentrations
-High heterotrophic bacterial abundance

Oligotrophic
-Low phytoplankton concentrations
-Lox bacterial abundance
-High oxygenation capacity
-Sinking of large particles

Low confinement
(High energy)

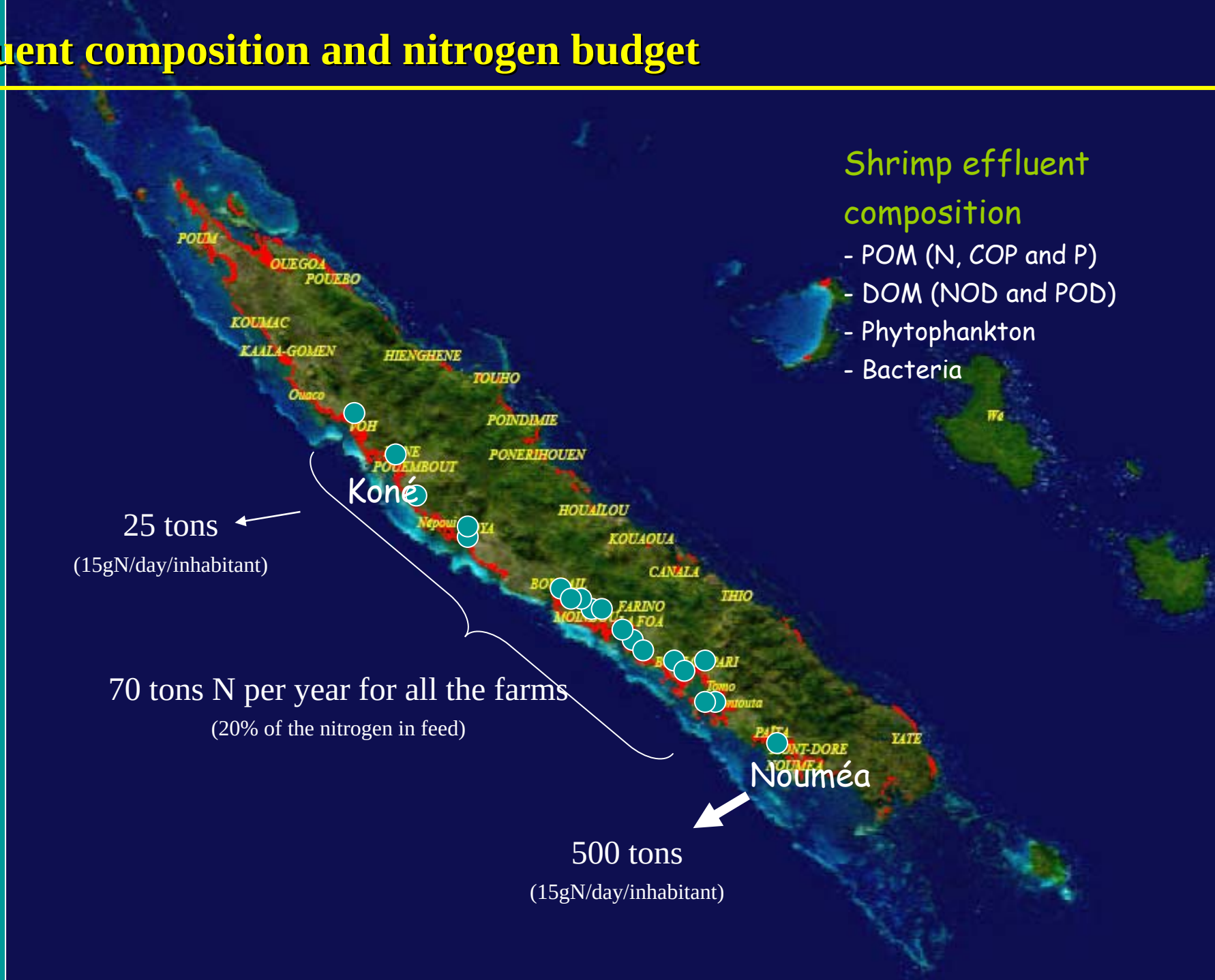
No aquaculture



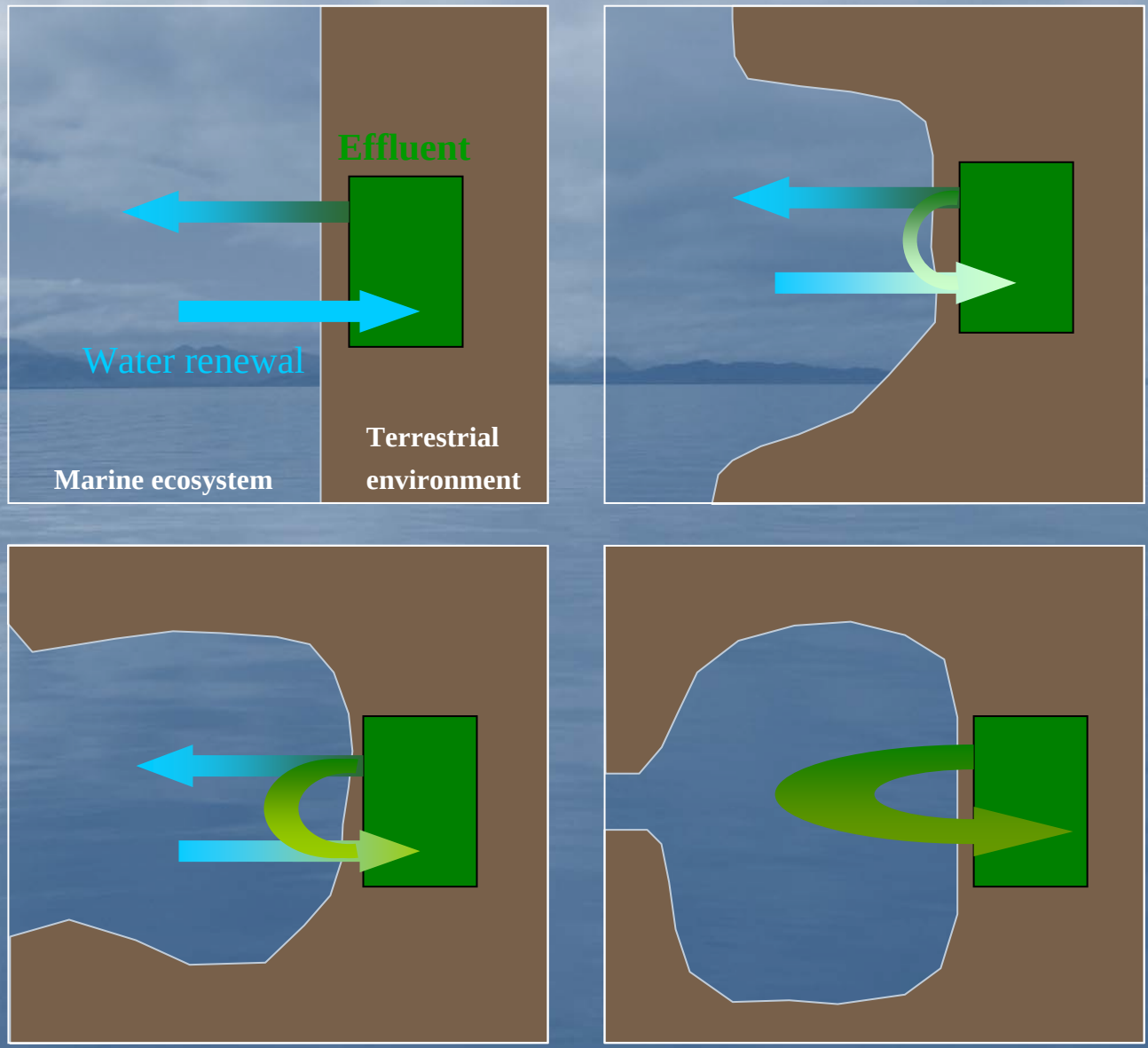
Capacity of production
(the darker the color, the higher the production)

European program “assessment of tropical shrimp aquaculture impact on the environment in tropical countries using hydrobiology, ecology and remote sensing as helping tools for diagnosis” (1994-1998)

Effluent composition and nitrogen budget



Effluent and water renewal*



Martin, J.L., 2003. Relations entre l'aquaculture et l'environnement côtier (impact, sélection de site, potentiel de production) : application à l'aquaculture de crevettes. In: Styli 2003. Trente ans de crevetticulture en Nouvelle-Calédonie. Nouméa-Koné, 2-6 juin 2003. Ed. Ifremer, Actes Colloq., 38, 226-240.

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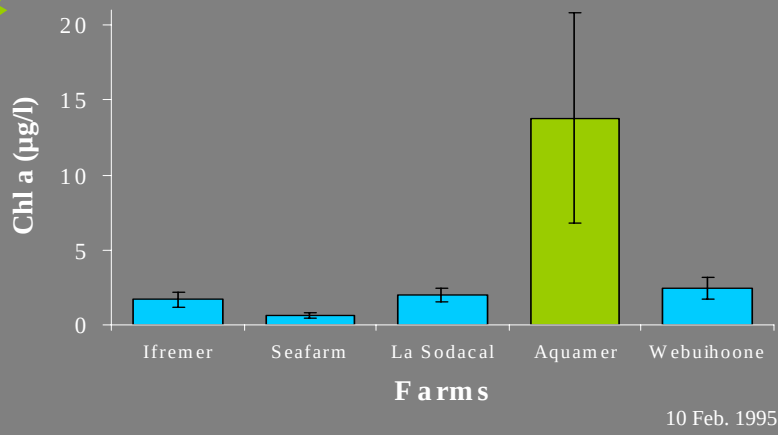
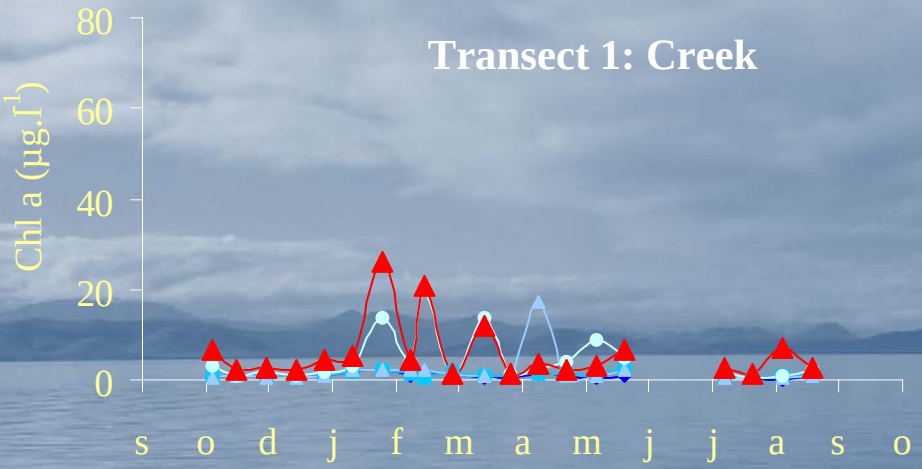


Effluent surveys in the lagoon

Effluent surveys in the lagoon

Farm activity



Lagoon water quality
Chl a < 0.5 µg.l^{-1}

Bay water quality
Chl a < 2 µg.l^{-1}

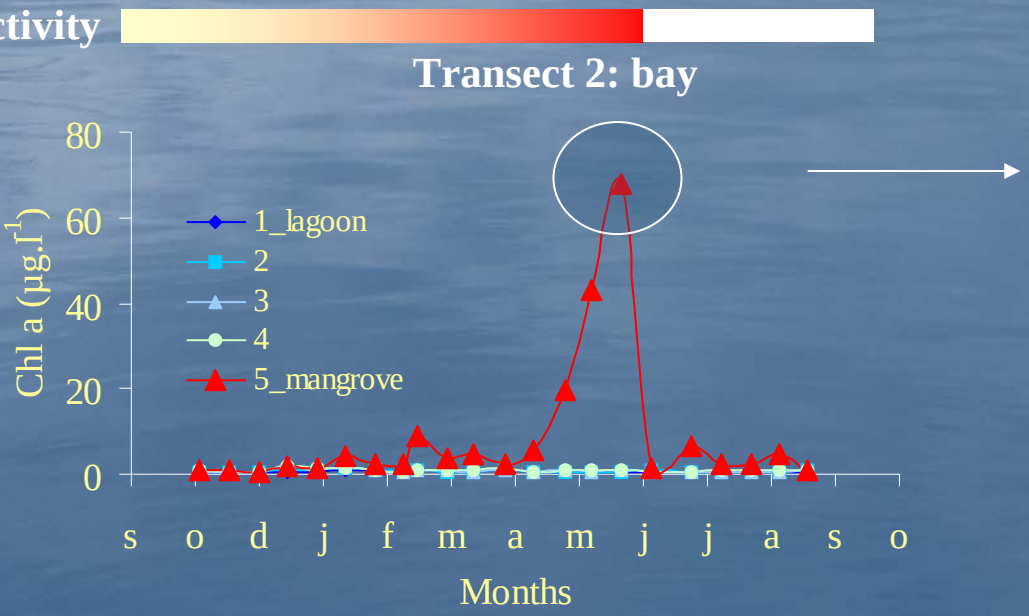
Bay near Nouméa
Chl a < 3 µg.l^{-1}

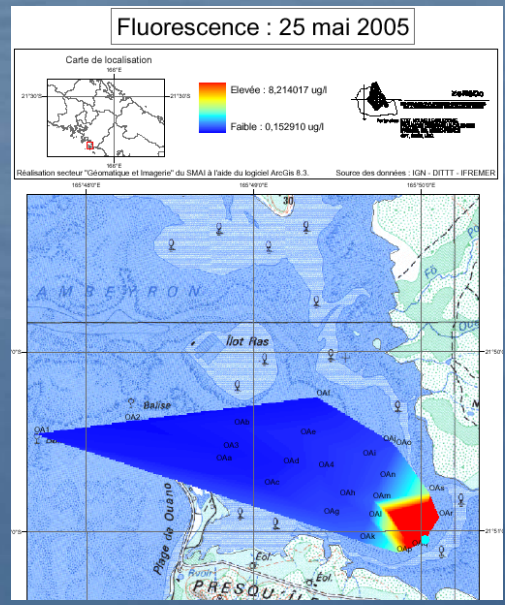
Oligotrophic system

↓

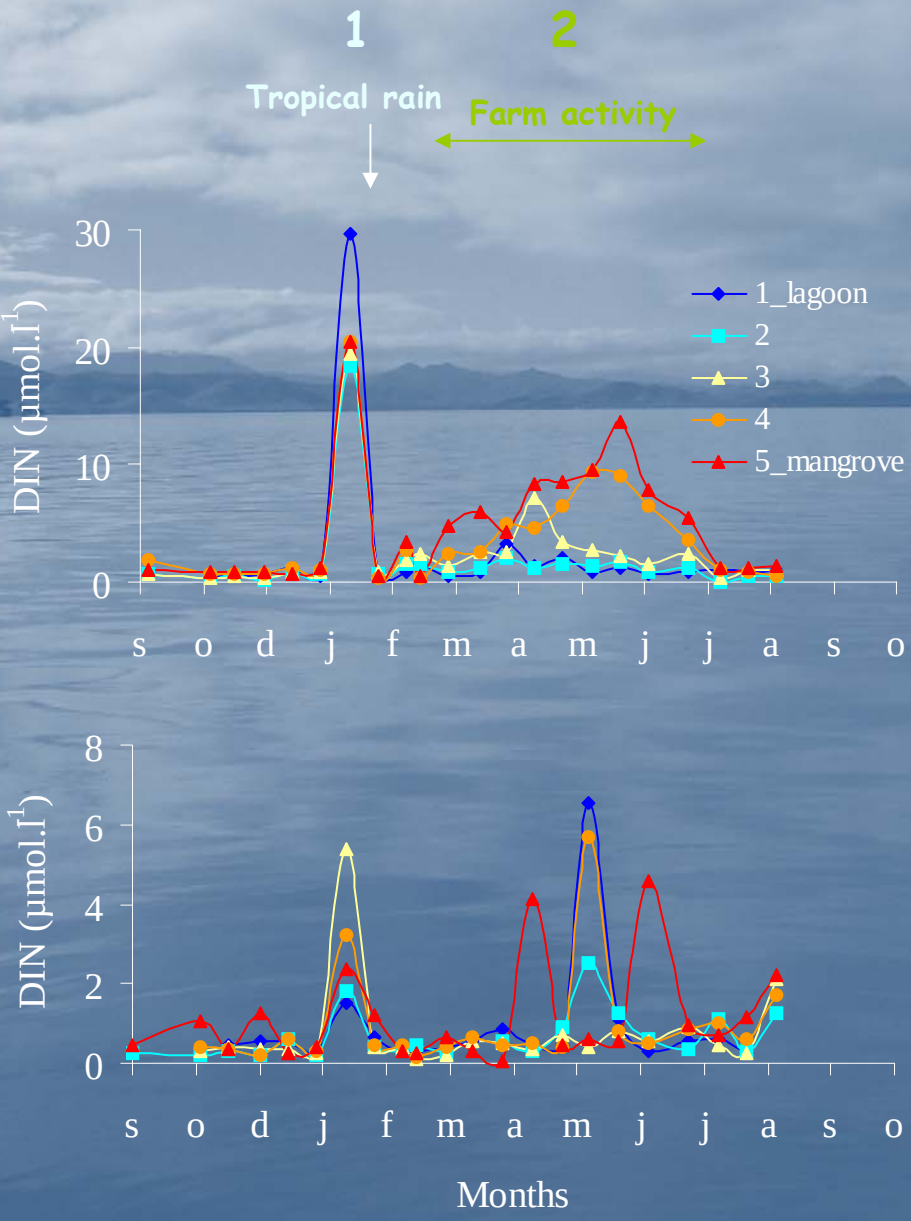
Mesotrophic system

Farm activity





Effluent surveys in the lagoon



Tropical rain → Leaching

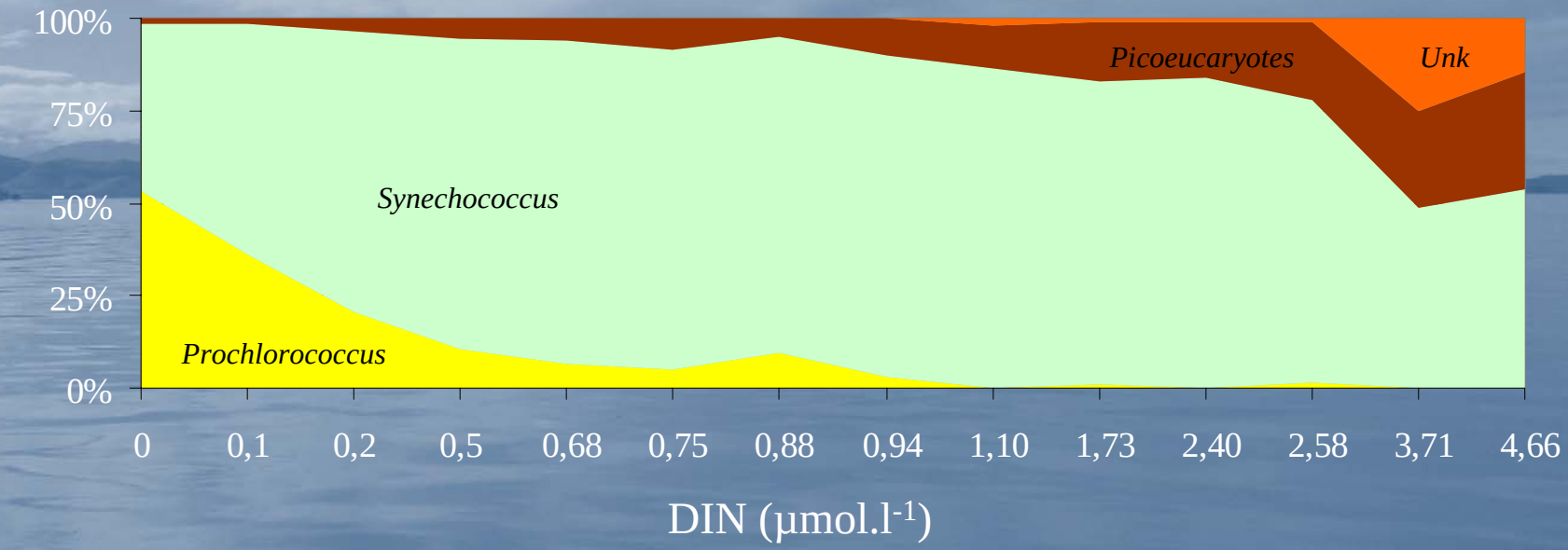
Effluent with high organic content → Mineralization

Leaching → Nutrients in bays

Mineralization → Nutrients in bays

Nutrients in bays ← - Natural processes
-Agriculture activities
-Aquaculture

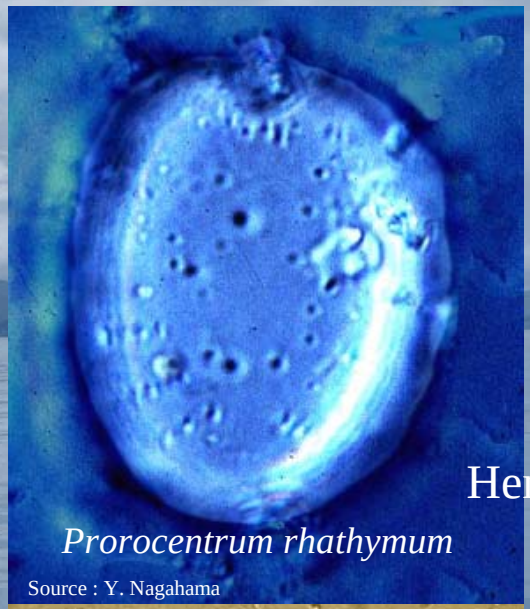
Effect of nutrients on phytoplankton communities



Sea | **Lagoon** | **bay** | **End of the bay** | **Creek**

Jacquet et al., 2006. MEPS 320: 65-78; Lemonnier et al., In prep

Red tide



Prorocentrum rhathymum

Source : Y. Nagahama

Source : Ifremer / J. Herlin

Hemolytic toxins

Source : Ifremer / J. Herlin

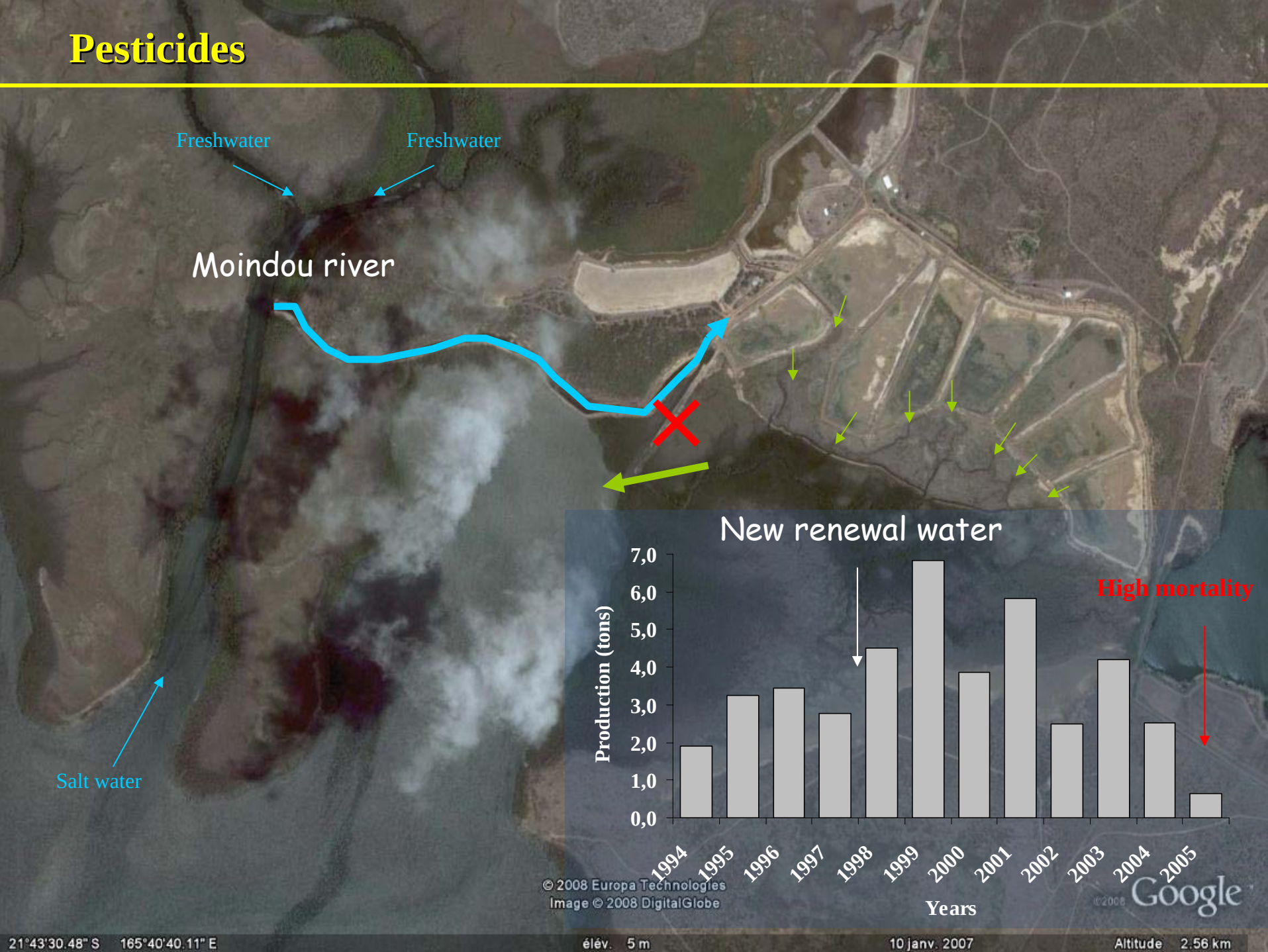
Protoperidinium steneii

E. Nézan

Red tide in a pond at the beginning of the rearing (Sept. 2003)

Red tide in a pond at the end of the rearing (January 2002)

Pesticides

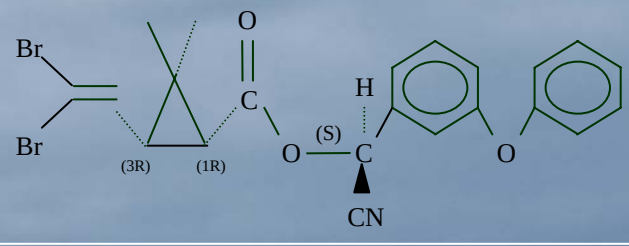

Freshwater
Freshwater
Moindou river
Salt water
New renewal water
High mortality
Production (tons)
7,0
6,0
5,0
4,0
3,0
2,0
1,0
0,0
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Years
© 2008 Europa Technologies
Image © 2008 DigitalGlobe
Google
21°43'30.48" S 165°40'40.11" E
élév. 5 m
10 janv. 2007
Altitude 2.56 km

Pesticides

Deltamethrin: Used by agriculture against insects

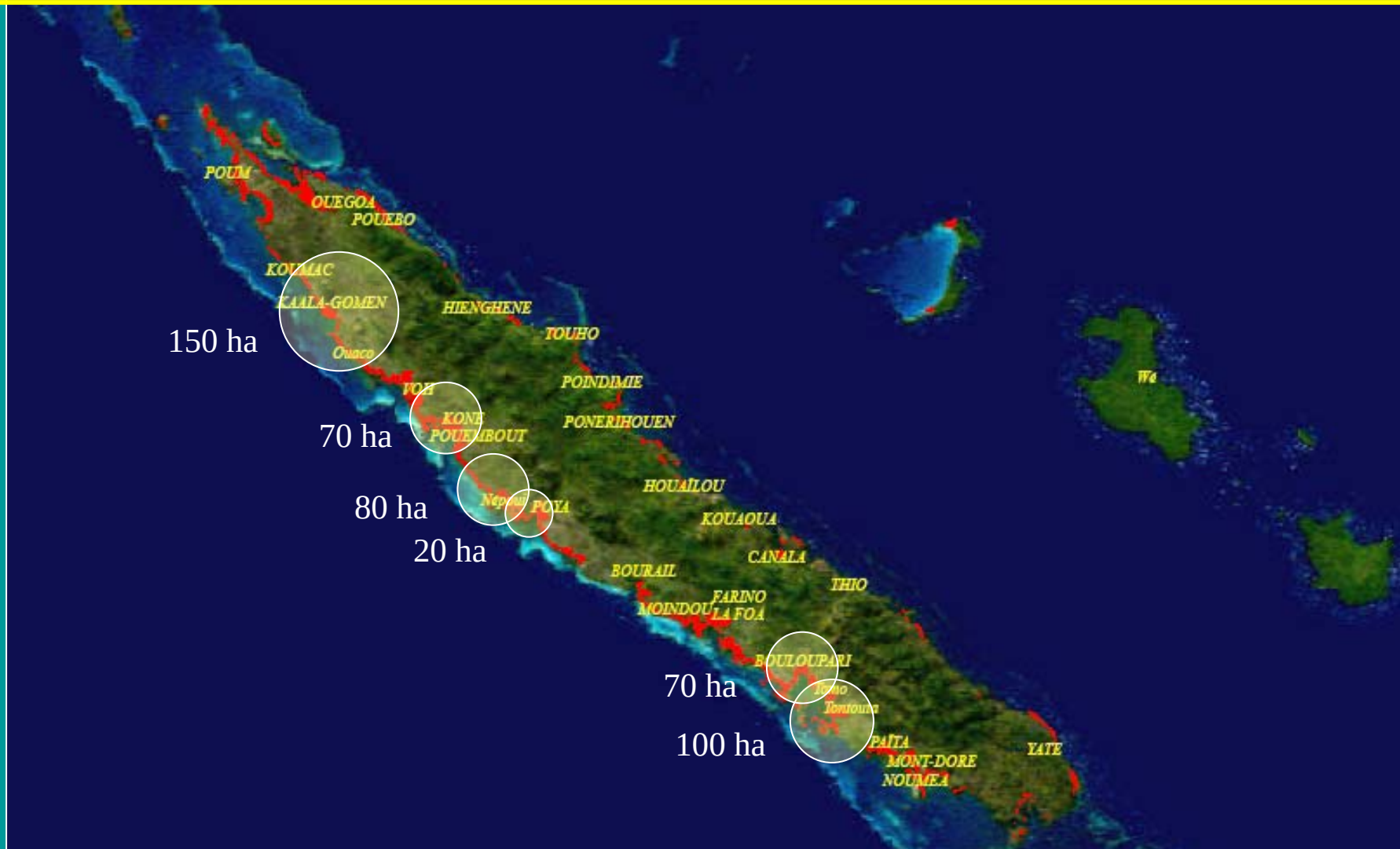
37 µg/l measured in the input water

- No mortality in ponds without water exchange
- Probably a toxicity problem
- The farm was closed in 2005



	Deltamethrin (µg/l) http://www.epa.gov/ecotox/
Americamysis bahia	0.016-0.037
Crangon septem.	nd
Gammarus pulex	0,03
Penaeus duorarum	0.35

Metal and aquaculture



Pond surface = 640 ha (production is about 2000 tons per year)

“Polluted” areas > about 500 ha

Metal and aquaculture

1 - Bioaccumulation of metal and metalloid in shrimp (Metian *et al.*, in prep)

→ Effect on the farm products

2 – Effect of metal and metalloid on shrimp survival

→ Productivity of the farms built on these areas?

Metal in the environment (soil and coastal water): a drawback to development ?

Need of more research on this topic

Conclusions

Necessity of monitoring, integrating the various components of the hydroystem, in view of preventing possible future conflict of uses.

The objective could be the comprehension of the processes and construction of tools of observation and representation, allowing a monitoring and a forecast of the quality of water, resources and coastal biotopes in interaction with the coastal environment and human activities.

RNO (Water quality surveillance)

REPHY (algal toxin surveillance)

Quadrige

http://www.ifremer.fr/envlit/surveillance/

Thank you for your attention